

WHAT IS CLAIMED IS:

1           1.       A method of delivering an occlusion element, comprising the steps of:  
2                   providing an occlusion element which is coupled to a delivery element with a  
3       dissolvable material, the dissolvable material being dissolvable with a fluid, the dissolvable  
4       material forming a dissolvable connection between the delivery element and the occlusion  
5       element;  
6                   advancing the occlusion element through a patient's vascular system with the  
7       occlusion element coupled to the delivery element with at least the dissolvable connection; and  
8                   dissolving the dissolvable material thereby releasing the occlusion element from  
9       the dissolvable connection with the delivery element.

1           2.       The method of claim 1, wherein:  
2                   the dissolving step is carried out with the dissolvable material being dissolved  
3       faster by the fluid as compared to other fluids contacting the material during the advancing step.

1           3.       The method of claim 1, wherein:  
2                   the providing step is carried out with the dissolvable material dissolving faster at a  
3       selected pH as compared to a pH of other fluids which the material contacts during the advancing  
4       step; and  
5                   the dissolving step is carried out by delivering a fluid having the selected pH to  
6       dissolve the dissolvable material.

1           4.       The method of claim 1, wherein:  
2                   the dissolving step is carried out with the dissolvable material and fluid being a  
3       solute and solvent.

1           5.       The method of claim 1, wherein:  
2                   the dissolving step is carried out by delivering a fluid to the dissolvable material,  
3       the fluid being an acid..

1           6.       The method of claim 1, wherein:

2 the dissolving step is carried out by delivering a fluid to the dissolvable material,  
3 the fluid being a base.

1 7. The method of claim 5, wherein the dissolvable material includes a  
2 material selected from the group consisting of zinc and iron.

1 8. The method of claim 1, wherein the dissolvable material is a polymer.

1 9. The method of claim 9, wherein the dissolvable material is a natural  
2 polymer.

1 10. The method of claim 9, wherein the dissolvable material is an alginate.

1 11. The method of claim 9, wherein the dissolvable material is a cross-linked  
2 polymer.

1 12. The method of claim 11, wherein the dissolving step is carried out by  
2 delivering a fluid including a cation which dissolves the cross-linked polymer.

1 13. The method of claim 8, wherein the polymer is in the form of polymer  
2 layers bonded together.

1 14. The method of claim 13, wherein the polymer is an acrylic polymer.

1 15. The method of claim 15, wherein the polymer is a methacrylate polymer.

1 16. The method of claim 13, wherein the dissolving step is carried out by  
2 delivering a fluid having a pH different than blood.

1 17. The method of claim 13, wherein the dissolving step is carried out by  
2 using a fluid having a salinity different than blood.

1 18. The method of claim 17, wherein the dissolving step is carried out with the  
2 fluid having a pH of 4-6.5.

1 19. The method of claim 17, wherein the dissolving step is carried out with the  
2 fluid having a pH of 8-9.5.

1 20. The method of claim 17, wherein the dissolving step is carried out with the  
2 fluid having a pH of less than 7.0.

1 21. The method of claim 17, wherein the dissolving step is carried out with the  
2 fluid having a pH of greater than 7.4.

1 22. The method of claim 1, further comprising the step of:  
2 changing a temperature of the dissolvable material during the dissolving step.

1 23. The method of claim 22, wherein:  
2 the temperature changing step is carried out by delivering the fluid at a  
3 temperature which changes the temperature of the dissolvable material.

1 24. The method of claim 22, wherein:  
2 the temperature changing step is carried out by directly heating the dissolvable  
3 bond.

1 25. The method of claim 24, wherein:  
2 the temperature changing step is carried out by using resistive heating.

1 26. The method of claim 1, wherein:  
2 the dissolving step is carried out by delivering the fluid to the material to dissolve  
3 the dissolvable material.

1 27. The method of claim 26, wherein:  
2 the dissolving step is carried out with the fluid being delivered through the  
3 delivery element.

1 28. The method of claim 27, wherein:  
2 the dissolving step is carried out with a tube positioned in the delivery element,  
3 the tube having a lumen, the tube and delivery element defining a space therebetween, the fluid

4 being delivered through one of the lumen and the space and the fluid being withdrawn through  
5 the other of the lumen and the space.

1 29. The method of claim 1, wherein:

2 the providing step is carried out with the occlusion element forming coils.

1 30. The method of claim 1, wherein:

2 the providing step is carried out with the dissolvable material having a cavity.

1 31. The method of claim 30, wherein:

2 the providing step is carried out with the cavity being a throughhole.

1 32. The method of claim 1, further comprising the step of:

2 positioning a blocking element to impede fluid contact with a least a protected  
3 portion of the dissolvable material, the blocking element being movable to a position spaced  
4 apart from the protected portion of the dissolvable material.

1 33. The method of claim 32, wherein:

2 the blocking element is positioned in a cavity in the dissolvable material.

1 34. The method of claim 33, wherein:

2 the providing step is carried out with the blocking element being a tube; and the  
3 method further comprising the step of retracting the tube to expose at least part of the dissolvable  
4 material.

1 35. The method of claim 33, wherein:

2 the providing step is carried out with the blocking element being a tube; and  
3 the dissolving step being carried out with the fluid passing through the tube.

1 36. The method of claim 1, wherein:

2 the providing step is carried out with a flexible sheath extending over the  
3 dissolvable material, the flexible sheath being attached to the delivery element.

1 37. The method of claim 1, wherein:

2 the providing step is carried out with the occlusion element having a portion  
3 embedded in the dissolvable material.

1 38. The method of claim 37, wherein:

2 the providing step is carried out with the embedded portion being embedded in the  
3 dissolvable material in an expanded position, the embedded portion being naturally biased  
4 toward a collapsed position; and

5 the dissolving step is carried out so that the portion of the occlusion element is no  
6 longer embedded in the material thereby permitting the portion to move toward the collapsed  
7 position.

1 39. The method of claim 37, wherein:

2 the providing step is carried out with the portion embedded in the material  
3 including a plurality of filaments.

1 40. The method of claim 37, wherein:

2 the providing step is carried out with the portion embedded in the dissolvable  
3 material being a coil.

1 41. The method of claim 1, wherein:

2 the providing step is carried out with the occlusion element having a plurality of  
3 flexible fibers embedded in the dissolvable material.

1 42. The method of claim 1, wherein:

2 the providing step is carried out with the portion embedded in the material  
3 including a ball.

1 43. The method of claim 1, wherein:

2 the providing step is carried out with the portion embedded in the material  
3 including a cage.

1 44. The method of claim 1, wherein:

2 the providing step is carried out with a flexible sheath covering at least a portion  
3 of the dissolvable material.

1 45. The method of claim 44, wherein:

2 the providing step is carried out with the sheath having openings therein.

1 46. The method of claim 45, wherein:

2 the providing step is carried out with the delivery element having a fluid  
3 distributing portion with openings for distributing the fluid;

4 the dissolving step being carried out to deliver the fluid through the openings in  
5 the distributing portion to dissolve the material.

1 47. The method of claim 46, wherein:

2 the providing step is carried out with the distributing portion being conical.

1 48. The method of claim 1, further comprising the step of:

2 moving the delivery element relative to the occlusion element after the dissolving  
3 step to fully release the occlusion element from the delivery element.

1 49. The method of claim 1, wherein:

2 the dissolving step fully releases the occlusion element from the delivery element.

1 50. The method of claim 1, wherein:

2 the providing step is carried out with the occlusion element having a blocking  
3 portion which isolates the material from the patient's blood;

4 the advancing step being carried out so that the blocking portion isolates the  
5 material from the patient's blood during the advancing step.

1 51. The method of claim 50, wherein:

2 the providing step is carried out with the blocking portion being a plug of  
3 material.

1 52. The method of claim 51, wherein:

2 the providing step is carried out with the plug of material being solder.

1           53.     The method of claim 50, wherein:

2           the providing step is carried out with the blocking portion being a disc.

1           54.     The method of claim 1, wherein:

2           the dissolving step is carried out with the fluid being a fluid selected from the  
3           group consisting of water, saline and the patient's own blood.

1           55.     The method of claim 1, wherein:

2           the providing step is carried out with the material being selected from the group  
3           consisting of sugar, salt, mannitol or a combination thereof.

1           56.     The method of claim 1, wherein:

2           the providing step is carried out with the delivery element having a plurality of  
3           occlusion elements; and

4           the dissolving step is carried out a number of times to sequentially release the  
5           plurality of occlusion elements.

1           57.     The method of claim 56, wherein:

2           the providing step is carried out with the delivery element including a tube in  
3           which the plurality of occlusion elements is positioned;

4           the dissolving step being carried out by moving the tube relative to the occlusion  
5           elements to expose the dissolvable material to the fluid.

1           58.     The method of claim 57, wherein;

2           the providing step is carried out with the tube having openings therein through  
3           which the fluid passes to contact the dissolvable material.

1           59.     The method of claim 58, wherein:

2           the providing step is carried out with the delivery element having an outer tube  
3           positioned around the tube; and

4           the dissolving step is carried out by delivering the fluid through a lumen  
5           positioned between the tube and outer tube.

1           60.     The method of claim 59, wherein:  
2           the dissolving step is carried out by withdrawing the fluid and dissolved parts of  
3     the dissolvable material through another lumen between the tube and outer tube.

1           61.     The method of claim 55, wherein:  
2           the dissolving step is carried out by using a first fluid to dissolve one of the  
3     dissolvable connections and a second fluid, different than the first fluid, to dissolve another of  
4     the dissolvable connections.

1           62.     The method of claim 1, further comprising the step of:  
2           detecting whether the occlusion element has been released from the delivery  
3     element.

1           63.     The method of claim 62, wherein:  
2           the detecting step is carried out by applying energy to the delivery element and  
3     detecting a change in a parameter thereby indicating release of the occlusion element.

1           64.     The method of claim 63, wherein:  
2           the detecting step is carried out by applying RF energy.

1           65.     The method of claim 64, wherein:  
2           the detecting step is carried out with the parameter being the standing wave ratio.

1           66.     A system for delivering a medical device to a patient, comprising:  
2           a delivery element; and  
3           a medical device coupled to the delivery element with a dissolvable material, the  
4     dissolvable material forming a dissolvable connection between the medical device and the  
5     delivery element, the dissolvable material being dissolvable with a fluid.

1           67.     The system of claim 66, wherein:  
2           the medical device is an occlusion element for occluding a vascular region.

1           68.     The system of claim 67, wherein:  
2           the delivery element has a lumen.



1           69.    The system of claim 68, further comprising:  
2           a fluid source coupled to the lumen.

1           70.    The system of claim 69, wherein:  
2           the fluid source contains a fluid selected from the group of fluids consisting of the  
3 patient's own blood, water, saline, and combinations thereof.

1           71.    The system of claim 66, wherein:  
2           the material is selected from the group of materials consisting of sugar, mannitol,  
3 salt and combinations thereof.

1           72.    The system of claim 66, wherein:  
2           the dissolvable material has a cavity.

1           73.    The system of claim 72, wherein:  
2           the cavity has a throughhole.

1           74.    The system of claim 66, further comprising:  
2           a blocking element positioned to impede fluid contact with a least a protected  
3 portion of the dissolvable material, the blocking element being movable to a position spaced  
4 apart from the protected portion of the dissolvable material to permit dissolution of the protected  
5 portion

1           75.    The system of claim 74, wherein:  
2           the blocking element is positioned in a cavity in the dissolvable material.

1           76.    The system of claim 75, wherein:  
2           the blocking portion is a tube positioned in the cavity.

1           77.    The system of claim 66, wherein:  
2           the medical device has an embedded portion which is embedded in the dissolvable  
3 material.

1           78.    The system of claim 77, wherein:

2 the embedded portion is embedded in the dissolvable material in an expanded  
3 position, the embedded portion being naturally biased toward a collapsed position after  
4 dissolution of the dissolvable material.

1 79. The system of claim 77, wherein:  
2 the portion of the delivery element embedded in the material has a plurality of  
3 filaments.

1 80. The system of claim 77, wherein:  
2 the portion embedded in the dissolvable material is a coil.

1 81. The system of claim 66, further comprising:  
2 a flexible sheath covering at least a portion of the dissolvable material.

1 82. The system of claim 81, wherein:  
2 the sheath has openings therein.

1 83. The system of claim 66, wherein:  
2 the delivery element has a fluid distributing portion with openings for distributing  
3 the fluid.

1 84. The system of claim 83, wherein:  
2 the distributing portion is conical.

1 85. The system of claim 66, wherein:  
2 the medical element has a blocking portion which protects the material from  
3 exposure to fluid outside the delivery device.

1 86. The system of claim 66, wherein:  
2 the blocking portion is a plug of material.

1 87. The system of claim 86, wherein:  
2 the plug of material is solder.

1 88. The system of claim 66, further comprising:

2 a catheter having a lumen;  
3 the delivery element being a wire;  
4 the medical device being mounted to the wire with the dissolvable material.

1 89. The system of claim 88, further comprising:  
2 a source of fluid coupled to the lumen, the fluid dissolving the material.

1 90. The system of claim 66, wherein:  
2 the delivery element has a helical element;  
3 the helical element contacting the dissolvable material to enhance the bond  
4 between the delivery element and the material.

1 91. The system of claim 66, wherein:  
2 the delivery element has a textured surface which contacts the dissolvable  
3 material.

1 92. The system of claim 66, wherein:  
2 the delivery element has a preloaded portion which exerts a force on at least one  
3 of the dissolvable material and the medical device.

1 93. The system of claim 92, wherein:  
2 the preloaded portion is compressed in a loaded position and is expanded when in  
3 a released position.

1 94. The system of claim 92, wherein:  
2 the preloaded portion is radiopaque.

1 95. The system of claim 94, wherein:  
2 the preloaded portion has a exposed portion which is exposed in the loaded  
3 position, the exposed portion moving inside the medical device when moving to the released  
4 position.

1 96. The system of claim 95, wherein:

2 the exposed portion is embedded in the dissolvable material, the dissolvable  
3 material being attached to the delivery element.

1 97. The system of claim 94, wherein:  
2 the preloaded portion includes a spring.

1 98. The system of claim 66, wherein:  
2 the medical device has a preloaded portion which exerts a force on at least one of  
3 the material and delivery element.

1 99. The system of claim 98, wherein:  
2 the medical device is an occlusion element having coils which are in an expanded  
3 shape when embedded in the material and which collapse when the material is dissolved.

1 100. The system of claim 66, further comprising:  
2 means for heating the material to enhance dissolution of the material.

1 101. The system of claim 100, wherein:  
2 the heating means uses electrical energy and is a resistive heater.

1 102. The system of claim 66, wherein:  
2 a number of medical devices are mounted to the delivery element.

1 103. The system of claim 102, wherein:  
2 a dissolvable connection is provided between each of the medical devices

1 104. The system of claim 103, wherein:  
2 at least two of the dissolvable connections are dissolved with different fluids.

1 105. A method of delivering a medical device, comprising the steps of:  
2 providing a medical device which is coupled to a delivery element with a  
3 dissolvable material, the dissolvable material being dissolvable with a fluid, the dissolvable  
4 material forming a dissolvable bond between the delivery element and the medical device;

5                   advancing the medical device into a patient with the medical device coupled to the  
6   delivery element; and  
  
7                   dissolving the dissolvable material thereby releasing the medical device from the  
8   delivery element.